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Impacts of Pastoral Activities on Nature Conservation in Western Uganda

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Abstract

Animals and the environment have had a close interaction dating back to pre-historical times. In as far as agricultural production is concerned, pastoral activities are the most important activities carried out in almost all regions in Uganda, due to the growing pressure to satisfy food demands, especially in form of meat, milk and eggs. However, in Western Uganda, this pressure has culminated into environmental degradation. The study focused on the environmental impacts of pastoral activities on nature conservation, while highlighting four major issues of concern. These issues include common livestock types and how they are reared, socio-economic and environmental benefits of livestock rearing, adverse environmental effects and how farmers are trying to mitigate the effects. While establishing the issues of concern, the study based on observation data collection together with use of questionnaires. Data was analyzed using the Statistical Package for Social Scientists (SPSS) software. Results show that cattle is the most common livestock type reared in the area, while other forms of livestock include goats, poultry and others. These are reared for various reasons such as food and income, but like all forms of food production, affect the environment in one way or another. Pastoralism, a common land use practice in Western Uganda, has negative environmental consequences, including damage to vegetation, reduction in water quality, etc. This calls for a more harmonious livestock-environment interaction and to achieve this, a number of measures have been suggested in this study, including enforcement of rules and regulations, sensitization of farmers on proper livestock rearing, tree planting and others, in a bid to ensure nature conservation.

1. Introduction

In the drylands of Africa, there are about 20 to 25 million pastoralists [1]. In many parts of sub Saharan Africa, pastoralists exploit the low opportunity cost of natural fodder on lands which are not suitable for sustainable agricultural production [2]. Traditional nomadic pastoralism has so far characterized the northern and southern fringes of the Sahara, the horn of Africa and arid areas in Uganda, Kenya and Tanzania as well as the arid zones of the Arabian Peninsula and of western and central Asia.

However, excessive concentration of animals in an increasingly limited area has brought about nature degradation through overgrazing [3]. Pastoralists depend almost exclusively on wood for their cooking and constructing enclosures to keep their animals together at night to prevent predators. These practices have had a negative impact on woody vegetation, pastures and soil and hence poor nature conservation [2]. Pastoral activities are very common in the cattle corridor of Uganda at the expense of subdued terrain stretching diagonally throughout the country – from Mbarara and Kiruhura through Kabarole, Masaka, Luwero, Nakasongola, Apach, Lira, Soroti, Kumi, Kotido and Moroto districts. In Uganda, the most prominent pastoralists are the Bahima in Kiruhura and Mbarara districts and the Karimojong in Kotido and Moroto districts [4]. In these areas, overgrazing is a serious problem and bush fires occur widely as part of rejuvenation of pastures. Among the Bahima of Sanga sub-county, where this study was conducted, are prominent pastoralists that move with their livestock from place to place, looking for pasture and water. During the process of movement with animal herds, vegetation is destroyed due to trampling, clearing of bushes for settlement and cutting down trees in construction of enclosures. The majority of the pastoralists practice commercial grazing and depend entirely on natural pasture. Since they keep as many animals as the natural environment can allow, pasture, vegetation, soil and water resources degradation has become inevitable [5]. Unfortunately, no research has ever been carried out in this region to address this environmental issue. It is against this background that this study was conducted.

The practice of herding large numbers of cattle has a significant negative impact on nature, culture and the socio-economic environment. According to Elhadi et al. [6], there is massive pressure on pastoral activities to satisfy the deeply rooted demand for high value animal protein. The increasing appetite of the rapid growing human population for meat, milk and eggs often translates into environmental damage and adverse effects on nature conservation. In a place such as Sanga Sub-County, where population growth and poverty coincide, poor management of pastoral activities has led to massive natural resource degradation through waste generation, soil erosion, de-vegetation, poor sanitary conditions and other effects that are environmentally undesirable. The major concern is that nothing seems to be on ground to try to harmonize the pastoralism-environment interaction. This study sought to resolve this critical issue and suggest priority intervention measures.

The general objective of this study was to assess the impacts of pastoral activities on nature conservation in Western Uganda.

The specific objectives of the study were: to identify the common pastoral activities and methods used in livestock rearing; to establish the socio-economic and nature conservation benefits of pastoral activities to the farmers; to find out the adverse nature conservation effects associated with pastoral activities; and finally, to evaluate measures

which farmers use to mitigate the negative nature conservation impacts associated with pastoral activities.

2. Materials and Methods

2.1. Description of the Study Area (The Environment)

2.1.1. Location

The study was carried out in and around Sanga sub-county (Fig. 1) located in Nyabushozi County (Fig. 2), Kiruhura District in Western Uganda. It is about 20kms from Mbarara town and just a short distance to the south of the Mbarara-Kampala highway. Sanga sub-county borders with Nyakahita, Rwakobo, Kanyaryeru, Kikasti and Nyakashashara sub-counties. Sanga sub-county has a total land surface area of about 208 km² [4].

2.1.2. Climate

Rainfall distribution in the area is of double maxima pattern, one in March and May and the second between September and November. Sanga being on a gently sloping area has water runoffs during these months, with heavy rains and this affects the livelihoods of many people in congested semi-permanent houses.

2.1.3. Soils

Soils in the county are of various types. In low lands, which comprise a greater part, soils are of black gray fine, redish brown course, hard clay loams and with a sandy structure; the soils are generally of high productivity except that rainfall scarcity, unreliability and unpredictability make crop performance very poor.

2.1.4. Vegetation

Vegetation in the county comprises of savannah (scattered trees and scrubs). Natural vegetation in most parts of the county does not exist due to primitive methods of cultivation such as shifting cultivation and bush burning in order to acquire fresh pastures for animals. Also, the disappearance of vegetation is connected to failing to meet the growing demand for fuel wood, charcoal burning, building materials like reeds, fibres, grasses and poles.

2.1.5. Socio-economic Activities

Sanga Sub-County has administrative, commercial and agricultural centers. Over 70% of the population is involved in pastoralism as their main economic activity. In terms of social services, Sanga Sub-County has a range of infrastructure in form of primary and secondary schools, a health centre, hydro electric power and a road network (murrum and tarmac).

2.2. Research Design

The research took place in the administrative unit of Sanga sub-county. It involved a case study research design where respondents were mainly livestock keepers resident in

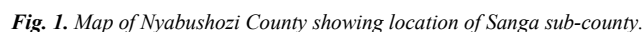
All livestock keepers or pastoralists stood the same chance of being selected.

- Purposive Sampling

This was used to obtain specific forms of data required from those pastoral farmers possessing vital information.

2.2.3. Sources of Data

- Primary data was mainly collected from pastoral farmers through field-based methods such as observation and questionnaire. Secondary data was obtained through literature search / review from available sources such as journal articles, text books, magazines, dissertations in libraries etc.



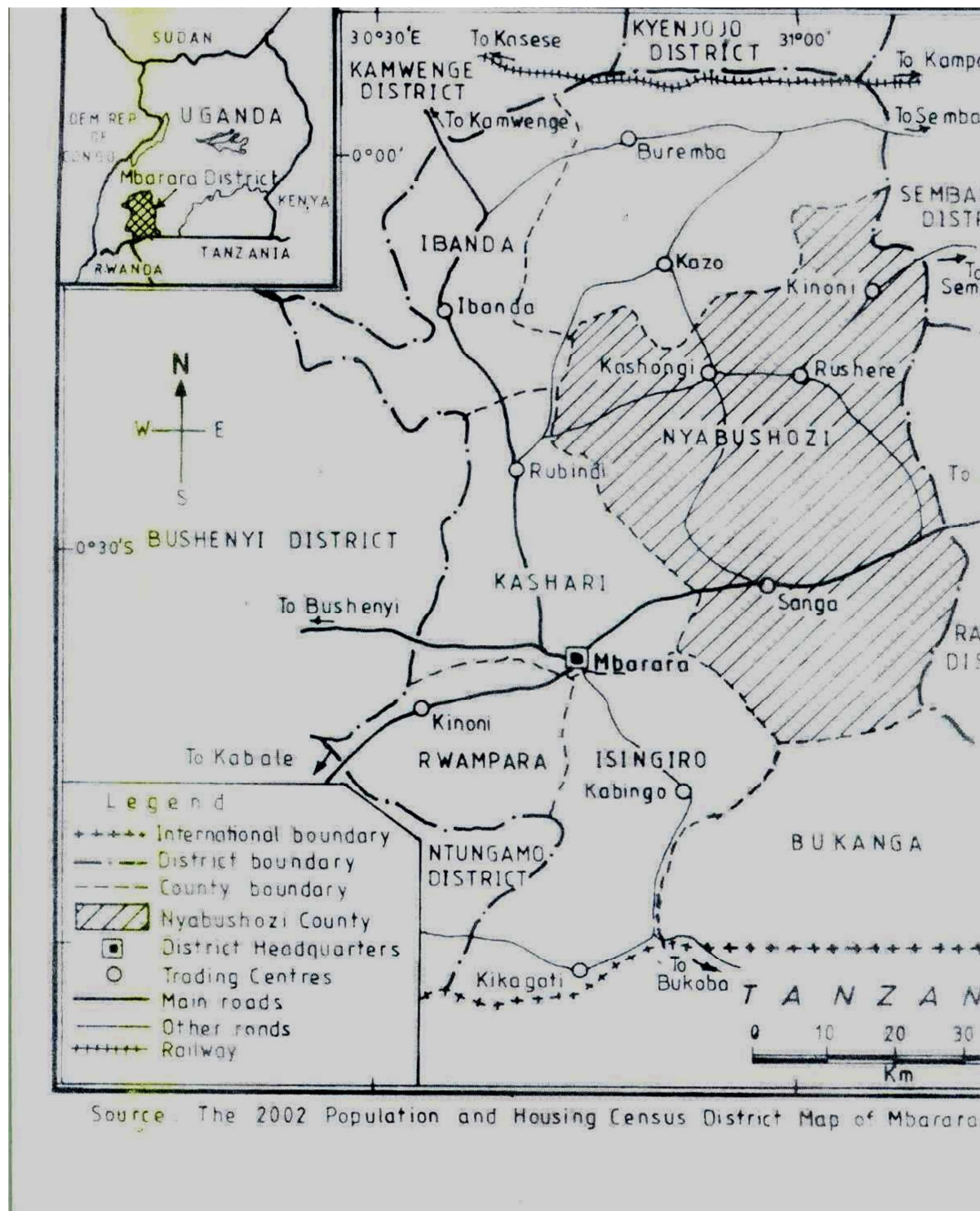


Fig. 2. Map of Uganda showing location of Nyabushozi County in Mbarara District.

2.3. Methods of Data Collection

- *The observation method*: this involved systematically watching and recording of the characteristics of the various pastoral activities within the study area. This method helped to relate the observed findings to the data generated from questionnaires.
- *Questionnaire method*: this involved administering questions to the respondents who completed them in written form. Both closed and open-ended questions were used.
- *The literature search method*: this consisted of data collected from various studies done before. Data was

gathered from text books, institutions and the Internet.

- *The Interview Method*: this was adopted for quick response, flexibility, easy and administrative access to direct information from the respondents.

2.4. Data Analysis

The data obtained was analyzed using the Statistical Package for Social Scientists (SPSS) software and Excel computer programs. It was compiled using several techniques such as sorting, classification, aggregation and survey tables and graphs. Analysis was done on various aspects of demographic profiles of the respondents such as sex, age and level of education, among others.

3. Results and Discussion

3.1. Characteristics of Respondents

Table 1. Characteristics of respondents.

Variable	Frequency	Percentage (%)
1. Sex:		
• Male	15	68
• Female	7	32
2. Age:		
• 15–25	3	13
• 26–35	7	32
• 36–45	6	27
• 46–65	6	27
3. Education		
• Primary	5	22
• Secondary	6	27
• Tertiary	6	27
• University	2	9
4. Occupation		
• Peasant farmer	10	45
• Business person	2	9
• Civil servant	4	18
• Student	2	9
• Community development volunteer	4	18
5. Marital Status		
• Single	2	9
• Married	17	77
• Separated	1	6
• Widow	1	6
• Widower	1	6
6. Monthly income level (UGX)		
• Less than 50,000		
• 50,000–100,000	14	63
• 100,000–150,000	2	9
• 150,000–200,000	2	9
• Over 200,000	4	18

Out of a total of 22 respondents, males were 15, representing 68% and females were 7, representing 32%. The females considered livestock keeping as an activity for males.

Thirteen percent (13%) of the respondents fell in the age category of 15–25, 32% were in the category of 36–45 and 27% were in the category of 46–65. It is therefore clear that the largest age group that took part in the study was that of 26–35, probably because they have more time to look after their livestock as compared to their counter parts (Karneback *et al.* [7]).

Table 1 shows that two of the respondents were single, representing 9%, 17 were married (77%), 1 was separated (6%), 1 was a widow (6%), 1 was a widower (6%). This means that the majority of the respondents were married followed by singles and the separated, widows and widowers were the least, both accounting for only 6%.

There were 10 peasant farmers (45%), 2 business persons (9%), 4 civil servants (18%), 2 students (9%) and 4 community development officers (18%). The peasants usually do not have sufficient income sources and therefore rely on agriculture (livestock keeping) to meet their income

and dietary needs. Pastoralism is the most important economic activity in Sanga Sub-county. This explains why peasant farmers contribute the largest portion of the respondents as compared to business people, students, civil servants and community development officers.

Out of a total of 22 respondents, 19 revealed their education levels, while 3 did not. Out of 38 valid responses, 5 (22%) attended primary education, 6 (27%) secondary education, 6 (27%) tertiary education, and only 2 (9%) acquired university education. This represents a low education level of the respondents as the majority acquired secondary and tertiary education. This probably explains why the majority of the respondents were peasant farmers who are the major livestock keepers in Sanga sub-county and also why the majority of them earn between 50,000–100,000 UGX (Uganda Shillings) monthly as illustrated in Table 1.

Fourteen (63%) earn 50,000–100,000 UGX, 2 (9%) earn 100,000–150,000 UGX, 2 (9%) earn 150,000–200,000 UGX and 4 (18%) earn above 200,000 UGX. Probably, most of the respondents earn between 50,000 and 100,000 UGX due to the low levels of education and the fact that the agricultural sector experiences a lot of financial uncertainties.

3.2. Common Livestock Types and How They Are Reared in Sanga Sub-county

3.2.1. Cattle

Cattle are the most common animals associated with agriculture found in Sanga sub-county. Cattle are also a common sight in Sanga sub-county where they can be seen grazing on drylands.

Table 2. Respondents who rear cattle.

Response	Frequency	Percentage (%)
Yes	17	77
None	5	23
Total	22	100

As shown in Table 2, 17 respondents rear cattle, representing 77%. The cattle are mainly reared for purposes of sale in form of meat and milk to diversify household incomes (Elhadi *et al.* [6]).

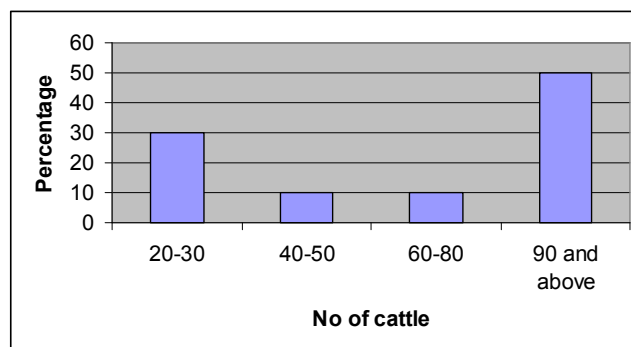


Fig. 3. Number of cattle reared by respondents.

As shown in Fig. 3, 30% of the respondents rear 20-30 heads of cattle, 10% rear 40-50 cattle, still 10% rear 60-80 where as 50% rear 90 and above. There are several methods employed in rearing the cattle (Fig. 4).

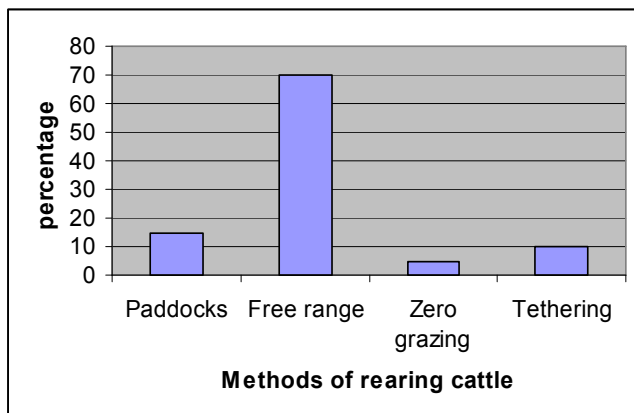


Fig. 4. Methods employed in rearing cattle by respondents.

Fig. 4 shows that 15% of the respondents paddock their cattle, perhaps because the paddocks are quite expensive to establish and maintain; 70% of the respondents use free range, 5% use zero grazing and 10% use tethering. Of all the methods used, free range is the one that poses serious environmental threats as the animals are left to roam around the pasture lands on their own.

3.2.2. Goats

Just like cattle, goats are a familiar sight in Sanga Sub-County; goats are reared for the same reasons as the cattle.

Table 3. Respondents who rear goats.

Response	Frequency	Percentage (%)
Yes	12	55
None	10	45
Total	22	100

Table 3 shows that 12 respondents rear goats, representing 55% and this is on a small scale as can be seen by the numbers of goats reared in Fig. 5.

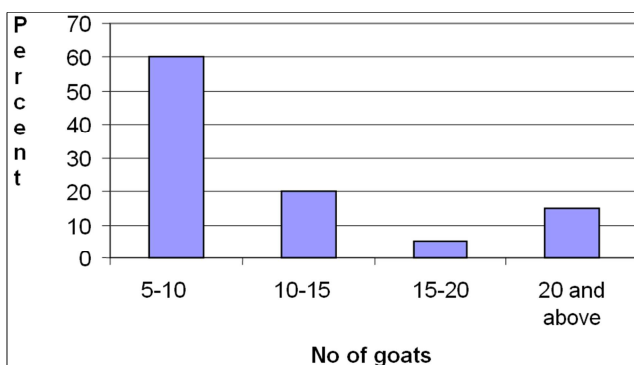


Fig. 5. Number of goats reared by respondents.

Results in Fig. 5 show that 60% of the respondents rear 5-10 goats, 20% rear 10-15 goats, 5% rear 15-20 goats, while

15% rear above 20 goats. Most of the respondents use free range to graze their goats. However, some of them also use tethering.

3.2.3. Sheep

Sheep were not so common in the study area as compared to cattle and goats.

Table 4. Respondents who rear sheep.

Response	Frequency	Percentage (%)
Yes	7	32
None	15	68
Total	22	100

From Table 4, sheep are reared by 32% of the respondents as compared to 77% and 55% who rear cattle and goats, respectively.

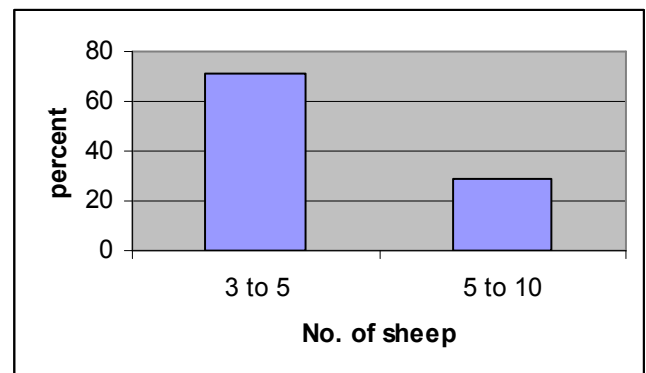


Fig. 6. Number of sheep reared by respondents.

Out of the 7 respondents (32%) who rear sheep, 5 rear 3-5 while only 2 rear 5-10 sheep, representing 71% and 29%, respectively (Fig. 6). The sheep reared form an important reserve for capital through the sale of the animals and mutton, mostly to the town residents. There are also various methods employed in rearing of sheep such as tethering, zero grazing and free range (Fig. 7). However, most of the sheep are reared alongside cattle.

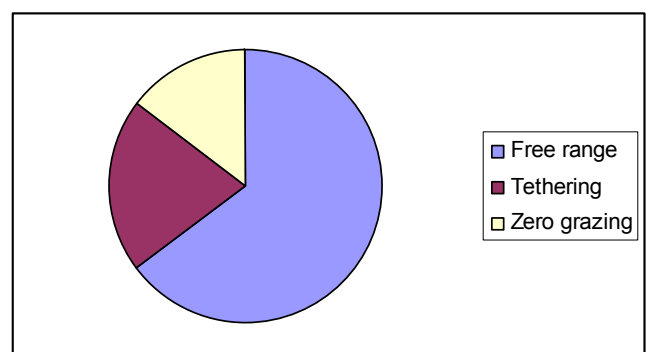


Fig. 7. Methods employed in rearing sheep.

3.2.4. Poultry

Chicken is the most common type of poultry reared in almost every part of Sanga Sub County.

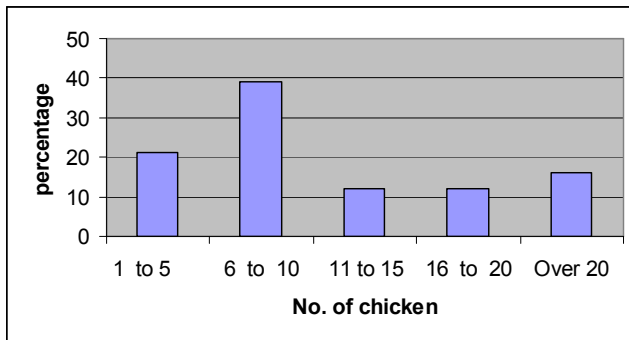


Fig. 8. Number of chicken reared by respondents.

From Fig. 8, 39% of the respondents rear 6-10 chicken, 21% rear 1-5 chicken, 15% rear over 20 chicken and 12% rear 11-15 and 16-20 chicken each.

3.3. Socio-Economic and Environmental Benefits of Pastoralism to the Residents of Sanga Sub County

3.3.1. Socio-Economic Benefits of Pastoral Activities to the Residents of Sanga Sub County

The socio-economic benefits of pastoralism in the study area include, among others, animal sales, food, customary requirements and animal exchange (Fig. 9).

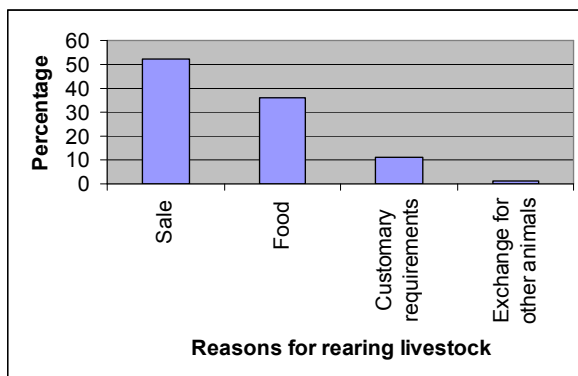


Fig. 9. Reasons for rearing livestock by the respondents.

i. Food

Thirty six percent (36%) of the respondents revealed that they mainly reared livestock for purposes of food especially in form of milk, ghee and meat (Fig. 10).

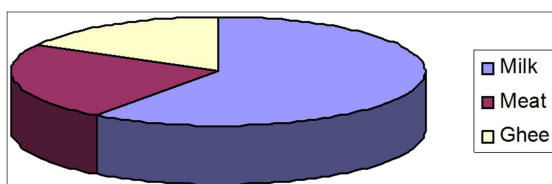


Fig. 10. Types of food obtained from pastoral activities.

Fifty nine percent (59%) of the respondents reported that milk is the most dominant type of food obtained from livestock such as cattle and goats. Animals such as cattle, goats and sheep further provide meat to the residents as

revealed by 24% of the respondents, while 17% of them derive ghee from cattle. Livestock therefore are a source of high quality animal protein and energy that can be consumed in periods of food shortage [8].

ii. Sale

Fifty two percent (52%) of the respondents reported that they rear livestock for purposes of selling them in order to obtain additional income to enable them afford basic household necessities. This is made possible because livestock are living banks of capital, providing financial reserves in periods of economic stress. Most of the respondents also agreed that they sell most of the livestock products such as meat, milk and ghee to local residents in the town, while some sell either products to the nearby villages and districts such as Sembabule and Masaka (Fig. 11).



Fig. 11. Consumers of livestock products of respondents.

Ninety three percent (93%) of respondents who rear livestock for purposes of sale have their market embedded within the sub county, while 4% sell their livestock products to the nearby villages and 3% to neighboring districts. However, despite efforts to raise sufficient incomes by most of the respondents, the income obtained through the sale of livestock products is not enough to meet all household expenditures. Most of the respondents stated other sources of income they get so as to be able to meet house hold expenditures. The sources included trading, remittances from relatives, selling labour, rent from tenants, selling agricultural produce and appreciation from voluntary work (Fig 12).

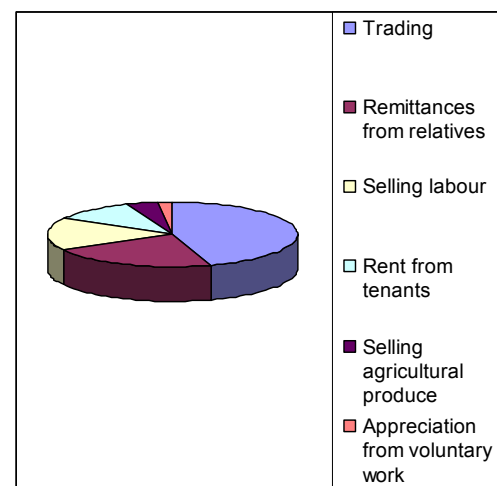


Fig. 12. Respondents' other sources of income.

Forty five percent (45%) of the respondents obtain additional income from trading, 22% obtain it as remittances from relatives, 16% obtain it through sale of labour on other peoples' plots of land, 11% obtain it from rent and 4% secure it from sale of agricultural produce such as maize, cassava and tomatoes, while only 2% obtain theirs as appreciation for voluntary work.

iii. Customary requirements

Eleven percent (11%) of the respondents rear livestock for purposes of customary requirements or as a cultural norm in

Africa where animals provide several services to the farming communities such as dowry.

iv. Exchange for other animals

Exchange for other animals also constitutes one of the reasons why livestock is reared by the residents in Sanga Sub County. The significance of this reason is however small, with only 1% of the respondents (Fig. 9). The animals raised are exchanged for other animals on friendly basis and/or during times of economic stress.

3.3.2. Environmental Benefits of Pastoralism in Sanga Sub County

Table 5. Environmental Benefits of pastoral Activities.

Environmental benefits of Pastoral activities.	Frequency	Percentage (%)
Improve soil cover by dispersing seeds	16	24
Remove biomass which might provide fuel for bush fires	10	18
Improve soil fertility by providing manure	38	55
Control the wild growth of vegetation	2	3
Total	66	100

i. Improvement of soil fertility

Improvement in soil fertility occurs through the provision of manure in form of dung from cattle, goats, sheep and poultry manure. Fifty five percent (55%) of the respondents were in agreement with this fact and that several farmers living in and around Sanga Sub County apply manure on their plots of land to increase soil productivity (Table 5). Generally, manure is among the most important contributions of pastoralism to the intensification of agriculture in Sanga Sub County.

ii. Improvement of soil cover

Twenty four percent (24%) of the respondents reported that livestock rearing helps in improving soil cover by dispersing seeds of various vegetation species such as trees and many forms of grasses with the help of their hooves and excreta (Table 5). Some of the respondents attributed the presence of certain trees (that were not planted by man) in the

Sub County to the existence of livestock. The trees and other forms of vegetation have helped to control soil erosion (at certain points) by significantly reducing wind and run off speeds.

iii. Reduction of incidences of bush fires

Live stock rearing in Sanga Sub County has a critical role to play in as far as reduction of incidences of bush fires is concerned as evidenced by 18% of the respondents (Table 5). This is made possible through grazing, thereby removing any kind of biomass that would consequently lead to fire outbreaks in the Sub County.

iv. Control of wild growth of vegetation

From Table 5, 3% of the respondents agreed that livestock has helped in controlling wild growth of vegetation in the Sub County and this has also helped to enhance the aesthetic beauty of the Sub County.

3.4. Adverse Environmental Impacts of Pastoralism in Sanga Sub County

Table 6. Negative environmental impacts of pastoralism.

Negative environmental effects of pastoral activities	Frequency	Percentage (%)
Damage to soil and vegetation	39	55
Decrease in water quality	5	7
Indiscriminate bush burning and over stocking	27	38
Total	71	100

3.4.1. Damage to Vegetation and Land

Damage to vegetation and land stands out as the most severe effect associated with pastoralism activities in Sanga Sub County. Fifty five percent (55%) of the respondents reported that livestock leads to damage of vegetation and soil (Table 6). This has mainly been brought about by the free range grazing system in this area, which consequently has led to deterioration of vegetation, a condition that has further increased incidences of soil erosion. The impacts of erosion

would be minimal if livestock were properly managed and more vegetation planted [9].

3.4.2. Decrease in Water Quality

Seven percent (7%) of the respondents reported that livestock keeping has increased pressure on the insufficient water sources available (Table 6). Given the small coverage of clean tap water, pollution of water sources through animal waste disposal has worsened the water situation, since the water becomes unsafe for human consumption.

3.4.3. Indiscriminate Bush Burning and Overstocking

The problem of over stocking in Sanga Sub County was identified by 38% of the respondents (Table 6). Rural livestock rearing has for long been associated with overstocking due to less land available for grazing, together with acute bush burning for new pasture regeneration [10]. This is therefore one of the reasons that make pastoral activities unfriendly to nature conservation. Overstocking of livestock has also led to easy spread of diseases.

3.5. Ways in Which Residents Are Trying to Mitigate the Negative Effects of Pastoralism in Sanga Sub County

Table 7. Mitigation Measures of Negative Environmental Effects of Pastoral Activities.

Mitigation Measures	Frequency	Percentage (%)
Advocacy for afforestation	22	37
Encouraging pastoralists to buy more land and settle down	7	12
Enforce bye- laws about bush burning	4	7
Rainwater harvesting	15	26
Sensitizing people on proper stocking rate	10	17
Total	58	100

Planting Trees

Thirty Seven percent (37%) of the respondents suggested that they plant trees to try to reduce effects of erosion from surface run off and also to increase the vegetation cover in order to prevent desertification (Table 7). However, they further suggested that it is the livestock halting their efforts to plant trees since they (livestock) usually browse on the leaves and stems of the young trees, thereby preventing them from growing normally [11]. The residents are however trying to protect trees by constructing protective structures around them so as to minimize the effects of grazing and charcoal burners [12]. Sensitization about the need for nature conservation is a way of mitigating the negative impacts of pastoralism on nature conservation in Sanga Sub County. Environmental education and outreach programs are mainly carried out by veterinary doctors and research assistants usually facilitated by NGOs.

4. Conclusions and Recommendations

Pastoralism plays a significant role in the lives of the pastoral farmers as well as in nature conservation in Western Uganda. However, just like all forms of food production and economic activity affect the environment in one way or another, pastoralism has also proved to be more of a liability than an asset in various ways. It is therefore important to strike a balance between pastoralism and nature conservation so as to be able to optimize man's use of environmental resources. In order to effectively manage pastoralism-environmental interaction to a sustainable level, rules and regulations should be enacted especially as regards the

numbers of livestock reared to ensure that the carrying capacity of the environment and its natural resources are not constrained. There is need for mass sensitization of residents in the sub county regarding proper livestock management systems and methods. The masses need to be taught about the sustainable ways such as the use of paddocks, tethering and zero grazing. They also need to know the negative effects associated with pastoralism on the conservation of nature.

In a bid to control the impacts of soil erosion in the sub county, more vegetation cover, especially trees need to be planted. Trees are very important in reducing wind speed and velocity of surface runoff which comprise the major soil erosion agents.

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References

- [1] Nyberg, G., Knutsso, P., Ostwald, M., Oborn, I., Wredle, E., Othieno, D. J., Mureithi, S., Mwangi, P., Said, M. Y., Jirstrom, M., Gronvall, A., Wernersson, J., Svanlund, S., Saxer, L., Geutjes, L., Karneback, V., Wairore, J. N., Wambui, R., Leeuw, J. D., Malmer, A., 2015. Enclosures in West Pokot, Kenya: Transforming land, livestock and livelihoods in drylands. *Pastoralism* 5, 25 doi: 10.1186/s13570-015-0044-7.
- [2] Egeru, A., Wasonga, O., Mburu, J., Yazan, E., Majaliwa, G. J., MacOpiyo, L., 2015. Drivers of forage availability: An integration of remote sensing and traditional ecological knowledge in Karamoja sub-region, Uganda. *Pastoralism: Research, Policy and Practice* 5, 19 doi 10.1186/s13570-015-0037-6.
- [3] Kgosikoma, O. E., Batisani, N., 2014. Livestock population dynamics and pastoral communities adaptation to rainfall variability in communal lands of Kgalagadi South, Botswana. *Pastoralism: Research, Policy and Practice* 4, 19 doi: 10.1186/s13570-014-0019-0.
- [4] NEMA (National Environment Management Authority)., 2000. State of the Environment Report for Uganda, Kampala.
- [5] Majekodunmi, A. O., Fajinmi, A., Dongkum, C., Shaw, A. P. M., Welburn, S. C., 2014. Pastoral livelihoods of the Fulani on the Jos Plateau of Nigeria. *Pastoralism: Research, Policy and Practice* 4, 20 doi: 10.1186/s13570-014-0020-7.
- [6] Elhadi, Y. A., Nyariki, D. M., Wasonga, O. V., 2015. Role of camel milk in pastoral livelihoods in Kenya: contribution to household diet and income. *Pastoralism: Research, Policy and Practice* 5, 8 doi: 10.1186/s13570-015-0028-7.
- [7] Karneback, V. N., Wairore, J. N., Jirstrom, M., Nyberg, G., 2015. Assessing gender roles in a changing landscape: diversified agro-pastoralism in drylands of West Pokot, Kenya. *Pastoralism: Research, Policy and Practice* 5, 21 doi: 10.1186/s13570-015-0039-4.

- [8] Mayanja, M. N., Rubaire-Akiiki, C., Greiner, T., Morton, J. F., 2015. Characterising food insecurity in pastoral and agro-pastoral communities in Uganda using a consumption coping strategy index. *Pastoralism: Research, Policy and Practice* 5, 11 doi: 10.1186/s13570-015- 0031-z.
- [9] Kima, S. A., Okhimamhe, A. A., Kiema, A., Zampaligre, N., Sule, I., 2015. Adapting to the impacts of climate change in the sub-humid zone of Burkina Faso, West Africa: Perceptions of agro-pastoralists. *Pastoralism: Research, Policy and Practice* 5, 16 doi: 10.1186/s13570-015- 0034-9.
- [10] Suleiman, H. M., Ahmed, A. G. M., 2013. Monitoring changes in pastoral resources in eastern Sudan: A synthesis of remote sensing and local knowledge. *Pastoralism: Research, Policy and Practice* 3, 22 doi: 10.1186/2041-7136-3-22.
- [11] Barrow, E., 2014. Shinyanga Forest: Retrofitting resilience to the Shinyanga Forest Landscape restoration case study, IUCN (International Union for the Conservation of nature). http://cmsdata.iucn.org/downloads/shinyanga_forest.pdf. Accessed 27 March 2015.
- [12] Opiyo, E. O. F., Wasonga, O. V., Nyangito, M. M., 2014. Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. *Pastoralism: Research, Policy and Practice* 4, 10 doi: 10.1186/s13570-014-0010-9.